

# Analysis of L/X-Band Phased Array Fed Cylindrical Reflector With Super-Quadric Projected Aperture for Cold Regions/ Soil Moisture Mission

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The need for spaceborne microwave radar instruments to address key science themes such as climate variation and prediction, global water and energy cycles, mesoscale and weather dynamics demands high performance antennas with large apertures. For example, to measure the freeze/thaw dynamics, snow characteristics and soil moisture as a seasonal constraint on weather dynamics, carbon and hydrological processes stipulates a synthetic aperture radar antenna with large aperture with dual-frequency (e.g., L/X-band) and multi-polarization operation capability. Moreover, to create an efficient spacebased system a shared aperture and radar electronics is desirable. The radar antenna must also have good scanning capability for wide swath coverage. Adequate sensitivity to soil moisture and frozen surface changes require observations at low frequencies (e.g., L-band). Hence a large aperture antenna with good beam efficiency is necessary to achieve adequate spatial resolution.

In this paper, we present a novel multi-frequency and polarization shared aperture phased array fed cylindrical reflector with super-quadric projected aperture boundary concept for dual-use for cold regions/soil moisture mission. In the analysis, the projected aperture boundary of the cylindrical reflector is specified by a super-quadric curve with three controlling parameters  $a$ ,  $b$ , and  $n$ . Parameters  $a$  and  $b$  are the lengths of the semi-axes of the projected aperture, and  $n$  is a parameter that can be chosen to control the shape of the curvature corners. The advantage of the super-quadric aperture is that it is amenable to computational simulation of the performances of the antennas with a variety of projected aperture sizes and shapes represented by various combinations of  $a$ ,  $b$  and  $n$ . Computational simulations has been performed based on brute force FFT evaluation of the radiation integral using physical optics approximation for the current distribution on the reflector.

Results are presented that demonstrate that far sidelobes levels (a source of noise and clutter) of a phased-array-fed cylindrical reflector can be monotonically reduced at a far angle from the peak of the beam with superquadric shaping of the projected aperture. This is done for focal to diameter ratio,  $F/D$ , of 0.4 as to keep the antenna assembly compact. It is shown that a superquadric aperture-shaping parameter,  $n$ , range 2 to 4, can be used effectively to reduce far-sidelobe levels. It is found that impact of the shaping parameter,  $n$ , on the reduction of far-sidelobe levels is more pronounced as the beam is scanned away from nadir where it is mostly needed. Conceptual design for an array feed to optimize the performance of the reflector is presented. The antenna-gain sensitivity at L/X-band to various shaping parameters,  $n$ , is given to help guide trade-off in antenna design.